Temporal trends in soil solution acidity indicators in European forests

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Atmospheric deposition of inorganic nitrogen and sulphur compounds was one factor in the acidification of temperate forest soils in large parts of Europe during the second half of the 20th century. By acting on mineral weathering and exchangeable element equilibrium, acidifying deposition mobilizes base cations (Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}) and aluminium into soil solution thereby enhancing base cation loss by leaching and the aluminium toxicity (mainly Al^{3+}) to fine roots and mycorrhizal fungi. Soil solution composition is thus a key indicator for the effects of air pollution on forest ecosystems and provides "real time" information about the equilibrium between solid/liquid soil phases, leading to change in soil chemistry over time.

In recent decades, sulphur and nitrogen deposition has strongly decreased in forests in western central Europe, but hasn't changed or has slightly increased in eastern and northern Europe (Waldner et al. 2014). The aim of this study is to evaluate the acidity status of soil solution chemistry in response to changes in deposition at ICP Forests intensive monitoring (Level II) plots where soil solution has been collected over the past two decades. Data from approximately 177 sites in 17 countries with at least 10 years of data have been selected for this study.

To date, data for analysis has been prepared; values reported as below detection limit or 'zero' have been replaced, collection dates added to earlier years and information relating to sampler depth, type and layer has been checked. Initial analysis confirms a significant decline in sulphate in soil solution. The next step is to assess changes in acidity over the monitoring period. This will be achieved by applying the Seasonal Mann-Kendall test to indicators of acidity (pH, BC:Al, ANC) with months as seasons. The sites will be grouped in categories of soil acidity based on pH and base saturation for this test.

Evaluation of factors driving the trends will be carried out by relating temporal trends in soil solution acidity to environmental factors such as atmospheric deposition, climate as well as stand and soil conditions using linear mixed models. In addition, indicators of temporal trends in soil solution acidity will be related to decadal changes in bulk soil acidity at a subset of plots where soil data are available from the first and second ICP Forests Level II soil condition surveys. Preliminary results of soil solution acidity indicators trends, and likely controlling factors at the European scale, will be presented.

Waldner, P., Marchetto, A., Thimonier, A., Schmitt, M., Rogora, M., Granke, O., Mues, V., Hansen, K., Pihl Karlsson, G., Žlindra, D., Clarke, N., Verstraeten, A., Lazdins, A., Schimming, C., Iacoban, C., Lindroos, A.-J., Vanguelova, E., Benham, S., Meesenburg, H., Nicolas, M., Kowalska, A., Apuhtin, V., Napa, U., Lachmanová, Z., Kristoefel, F., Bleeker, A., Ingerslev, M., Vesterdal, L., Molina, J., Fischer, U., Seidling, W., Jonard, M., O'Dea, P., Johnson, J., Fischer, R., Lorenz, M., 2014. Detection of temporal trends in atmospheric deposition of inorganic nitrogen and sulphate to forests in Europe. Atmospheric Environment 95, 363-374.